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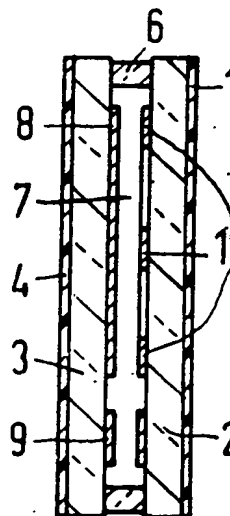
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(54) Improvements in or relating
to passive electro-optical displays

(57) A passive electro-optical display for the representation of symbols, comprises front (2) and back (3) spaced plates, provided on their opposed faces with segment electrodes (11) on the front, and a common electrode (8) on the back, and between them enclosing a medium, e.g. a liquid crystal material, optically changed by activating the electrodes. To monitor failure of the segments, the front plate (2) carries e.g. five additional control electrodes opposite an additional common rear electrode (9), each connected to a segment electrode (11) whose failure could lead to undetectable error. The rear electrode (9) is pulsed when the critical symbol is displayed, if not in error causing all control electrodes to flash.

Fig. 1



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Fig.1

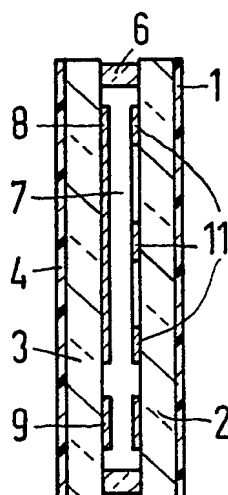
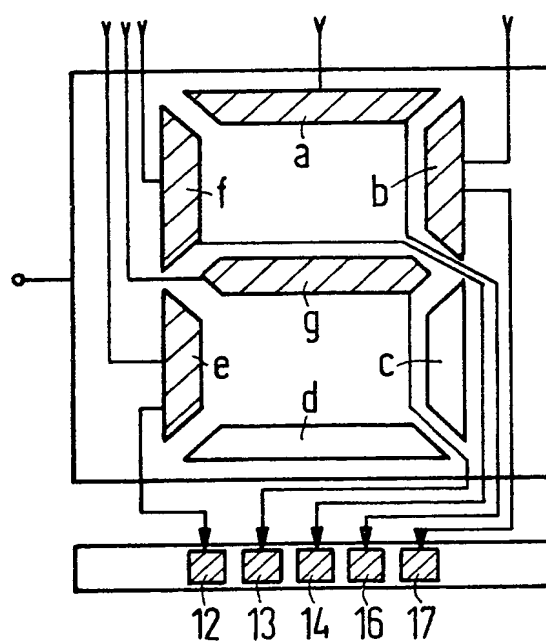


Fig.2



SPECIFICATION

Improvements in or relating to passive electro-optical displays

5 The present invention relates to a passive electro-optical display for the representation of optical items of information, such as digits, letters, or other symbols, the display comprising a front and a rear carrier plate in parallel spaced relationship, which plates on their opposed faces each carry separately operable electrodes, the electrodes on the front plate being in the form of individually operable segmental electrodes from selected ones of which a symbol can be built up, and said plates enclosing between them a medium (particularly a liquid crystal material) which can be switched zone-wise between optically differing states by the application of voltage between the front and rear electrodes. Displays of this kind, in contrast to active displays, do not produce their own light but merely modulate external light, can be constructed in various ways and have been commercially available for several years in a number of designs. A review of possible display principles is given, for example, by H.E. Bergt and K.H. Walter in "Elektronik" 4, 1976, pages 36-42; a summarised review is given in "Nachrichtentechnische Zeitung" 28, 1975, pages K62 and K63.

Even when the display is carefully produced, it is not possible to prevent individual segments from not being activated or being erroneously activated during the course of operation. Malfunctions of this kind which can have various origins (breaks in the conductor paths, breakdown of individual drive lines, short-circuits in the region of the switchable medium), frequently leads to an incorrect display which cannot be detected by the observer and which in many applications, for example, in calibration instruments or measuring devices, cannot be permitted.

In active displays, for example LED displays, the representation can be checked relatively simply; the segment currents are measured and compared with the offered (coded) items of information, and when necessary, a fault signal is triggered. However, this kind of monitoring cannot be used for passive displays, in particular liquid crystal displays, in which the segment currents are lower by several orders of magnitude than with active displays and which fluctuate to a relatively considerable extent. Hitherto, this situation has been remedied either by the provision of redundant representations (see German Patent Specification N° 2,402,749), or by the use of more extensive segmentation (see German Patent Specification N° 2,459,488), all of which measures undoubtedly involve a considerable additional outlay in terms of production costs and/or circuitry required.

It is an object of the present invention to provide a passive electro-optical display of the type described above, in which malfunctions of the segmental electrodes are overcome in a simple and relatively low cost manner.

According to the invention, there is provided a passive electro-optical display, comprising front and rear carrier plates arranged in parallel spaced relationship and enclosing between them a medium which can be electrically switched zonewise between optically-differing states, the opposed faces of said plates being each provided with electrodes; said front plate being provided with a plurality of individually operable segment electrodes, from selected ones of which a required symbol or symbols can be constructed, and said rear plate being provided with a rear electrode lying behind said segment electrodes in the direction of viewing the display; wherein for the monitoring of malfunctions of said display, a plurality of additional front control electrodes are provided on said front plate, each of said front control electrodes being electrically connected to a respective one of those segment electrodes malfunctioning of which would result in the display of a different symbol or symbols to the symbol or symbols required, and a separately-operable additional rear control electrode is provided on said rear plate located behind said front control electrodes in the direction of viewing the display.

The invention is based on the realisation that with practically every kind of segmentation, in the case of a malfunction in a greater or lesser part of the total number of segments, a malfunction of one or more of these segments will lead to a representation which will be immediately recognised as faulty. Thus if provisions are not made for the control of only the remaining, really critical segment electrodes, a basically adequate monitoring can be achieved at a relatively low extra cost. The requirement for checking can be kept within limits when, in accordance with the invention, the control is carried out by means of additional electrodes provided on the two carrier plates.

When the display is required to represent multi-digit numbers with comma-segment electrodes between the electrodes used to form the individual digits, preferably each of the comma-segment electrodes is provided with its own front control electrode electrically connected thereto.

The invention will now be further described with reference to the drawings, in which:-

Figure 1 is a schematic side-sectional view of a passive liquid crystal display according to the invention; and

Figure 2 is a front view of the electrode arrangement of the display of Fig. 1.

In the Figures, components of the display which are not essential for the understanding of the invention, for example, the electric

supply lines and terminals, have been either left unreferenced or even omitted.

Fig. 1 illustrates a single-digit display using a liquid crystal as the switchable medium.

- 5 This display operates on the principle of a so-called "rotary cell" and comprises a front linear polariser 1, a front carrier plate 2, a rear carrier plate 3, and a rear linear polariser 4 which is parallel to the front linear polariser.
- 10 The two carrier plates are spaced from one another by a peripheral frame 6. The chamber delimited by the frame and the opposed faces of the two plates is filled with a liquid crystal material 7. Further details of the production and operation of such a rotary cell are given in German Patent Specification N° 2,158,563.

- On their opposed faces, the two carrier plates 2 and 3 are each provided with separately operable, conductive coatings. As can be most clearly seen from Fig. 2, the back carrier plate 3 carries two rear electrodes (a digit rear electrode 8 and a control rear electrode 9). On the front plate 2 there are initially arranged seven segment electrodes 11 which in known manner are arranged to form the number "8". These consist of an upper transverse electrode *a*, a central transverse electrode *g*, a lower transverse electrode *d*, a left-hand upper upright electrode *f*, a right-hand upper upright electrode *b*, a left-hand lower upright electrode *e* and a right-hand lower upright electrode *c*. Each of these segment electrodes is provided with its own supply line.

- 35 When the seven-segment representations of the digits 0 to 9 in the conventional manner are analysed, it can be seen that in the event of the breakdown or misactuation of any of the segment electrodes *a*, *b*, *e*, *f* and *g* (which are shown shaded in Fig. 2, and which are hereinafter referred to as "dangerous" electrodes), other possible digits are formed: for example, if a "9" is intended and the segment electrode *f* should not be actuated the display would indicate a "3". In all such cases, an observer would be unable immediately to detect that the display was incorrect. The functioning of the "dangerous" segment electrodes listed above is therefore monitored.
- 50 For this purpose, individual control electrodes 12, 13, 14, 16 and 17 are provided on the carrier plate 2 below the area occupied by the actual digit. Each of these control electrodes is electrically connected to a respective one of the "dangerous" segment electrodes. Of the two rear electrodes, the digit rear electrode 8 lies opposite the digit segments *a* to *g*, whilst the control rear electrode 9 is arranged behind the control electrodes, considered in the direction of viewing the display.

- The display is operated in the following way. In a first step, the seven segments *a* to *g* are operated in accordance with the digit to be displayed, and the rear electrode 8 is activated. As a second step, the control elec-

trodes and the rear electrode 9 are operated. Preferably, all the control electrodes are switched on and off periodically, for example, in intervals of a second.

- 70 As compared with a liquid crystal display without control facilities, in the exemplary embodiment described a certain additional outlay is required which is, however, fully justified by the final result: the display requires one extra terminal, has a somewhat more complex electric conductor layout and must be provided with a liquid crystal material which permits a two-step multiplex operation. Moreover, the second rear electrode requires an additional drive means. Finally the drive arrangement must be designed for two-step multiplex operation and must contain an additional logic element in order to operate the segment electrodes to be controlled and a flashing device for switching the control electrode on and off.

- A display in accordance with the invention is monitored in the following way. During operation, all the symbols to be represented must correspond to the characters produced by the display. At no time may an invalid character be represented. The control elements are all therefore either switched on or switched off. If one control electrode only is indicating incorrectly, the represented information is also faulty.

- The invention is not, of course, limited to the exemplary embodiment illustrated in the drawing. Thus, in addition to a liquid crystal display, the invention can be applied to other passive electro-optical displays and, under certain circumstances, even to displays which would permit a segment current control, since when part of the control function is transferred to the observer the cost is always reduced. The digits to be represented can also be segmented differently (see German Patent Specification N° 2,520,650) or can be entirely different symbols and even matrix representations. Moreover, under certain circumstances, it may also be advisable to supplement the optical control by an additional electronic control within the drive component. This can be effected, for example, by recording the capacitive segment currents which can easily be increased when required, for example, by connecting additional capacitors. Moreover, the multiplex stepped operation for controlling "dangerous" segments can be combined with a multi-step-multiplex operation for the information representation, as will be readily apparent to an expert in this field (see German Patent Specification N° 2,163,634).

- 125 In addition to its use in calibrating instruments or measuring devices, such as scales, the display of the present invention is also very suitable for use in cash registers and petrol pumps, e.g. filling station pumps.

CLAIMS

1. A passive electro-optical display, comprising front and rear carrier plates arranged in parallel spaced relationship and enclosing between them a medium which can be electrically switched zonewise between optically-differing states, the opposed faces of said plates being each provided with electrodes; said front plate being provided with a plurality of individually operable segment electrodes, from selected ones of which a required symbol or symbols can be constructed, and said rear plate being provided with a rear electrode lying behind said segment electrodes in the direction of viewing the display; wherein for the monitoring of malfunctions of said display, a plurality of additional front control electrodes are provided on said front plate, each of said front control electrodes being electrically connected to a respective one of those segment electrodes malfunctioning of which would result in the display of a different symbol or symbols to the symbol or symbols required, and a separately-operable additional rear control electrode is provided on said rear plate located behind said front control electrodes in the direction of viewing the display.

2. A display as claimed in Claim 1, wherein said medium is a liquid crystal material.

3. A display as claimed in Claim 1 or Claim 2, adapted to display one or more digits; wherein seven segment electrodes are used for the or each digit, the segment electrodes comprising upper, central and lower transverse segments, upper and lower left-hand upright segments and upper and lower right-hand upright segments, together forming the digit "8"; and wherein five front control electrodes are provided for the or each digit, the electrodes being respectively connected to the upper and central transverse segments, the upper and lower left-hand upright segments and the upper right-hand upright segment.

4. A display as claimed in any one of Claims 1 to 3, for the representation of multi-digit numbers with commas between individual digits, the commas being formed by individual comma-segment electrodes; wherein each of said comma-segment electrodes is provided with a respective front control electrode electrically connected thereto.

5. A passive electro-optical display substantially as hereinbefore described with reference to and as shown in the drawing.

6. A calibrating instrument including a passive electro-optical display as claimed in any one of Claims 1 to 5.

7. A measuring device including a passive electro-optical display as claimed in any one of Claims 1 to 5.

8. A cash register including a passive electro-optical display as claimed in any one of Claims 1 to 5.

9. A petrol pump including an electro-

optical display as claimed in any one of Claims 1 to 5.

10. A method of operating a display as claimed in any one of Claims 1 to 4, wherein all the front electrodes and the rear control electrode are operated together automatically.

11. A method as claimed in Claim 10, wherein all the front control electrodes and the rear control electrodes are automatically switched on and off at specific time intervals.

12. A method of operating a display as claimed in any one of Claims 1 to 4, wherein in a first step of a two-step multiplex operation the segment electrodes and the rear electrode lying behind them, are operated in accordance with the symbol to be represented, and in a second step, all the front control electrodes and the control rear electrode are operated.

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